

# The Great Lakes Fisheries Leadership Institute

## Introduction to Fisheries Management

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# What is Fisheries Management?

The manipulation of aquatic organisms (POPULATIONS), aquatic environments (HABITAT), and human users (PEOPLE) to produce sustained benefits for humanity (Nielsen 1999 in “Inland Fisheries Management in North America, edited by Kohler and Hubert)

- Because we are managing for human benefits, we need to decide what is “beneficial”

# The Eight (Nine) Steps of Management

- 
1. Set Goals
  2. Examine the Resource
  3. Analyze the Situation and Set Objectives
  4. Prescribe Treatment
  5. Organize Personnel and Resources
  6. Implement
  7. Evaluate
  8. Maintain
  9. Publish

# The Eight Steps of Management

Critical Points For Public Involvement

1. Set Goals ←
2. Examine the Resource
3. Analyze the Situation and Set Objectives ←
4. Prescribe Treatment
5. Organize Personnel and Resources
6. Implement ←
7. Evaluate ←
8. Maintain ←
9. Publish

# The Eight Steps of Management

What is “the” most critical step?

# The Eight Steps of Management

What is “the” most critical step?

Setting Goals and Objectives

# The Eight Steps of Management

Goals: Broad statement of desired outcome  
of management

Healthy ecosystem

Good fishing

Productive forest

Safe water



# Evolution of Fishery Management Goals

Maximum utilization (fisheries are unlimited)

Maximum sustainable yield (MSY)

Optimum sustainable yield (OSY)

OSY + Healthy ecosystem/Biotic Integrity

# Public Trust Doctrine

The Public Trust Doctrine is a common law doctrine. The essence of the Doctrine is the legal right of the public to use certain lands and waters. The right may be concurrent with private ownership. The legal interest of the public is not absolute; it is determined by a balancing of interests.

The rights of the public are vested in each **STATE** as owner and trustee of Trust lands. The Public Trust Doctrine arises from the fact that Trust lands are special in nature physically and legally. Historically, the public use of these waters and lands was crucial for sustenance, travel, and commerce.

B. Black's Law Dictionary defines the public trust doctrine as a doctrine which, "Provides that submerged and submersible lands are preserved for public use in navigation, fishing, and recreation and the state, as trustee for the people, bears responsibility of preserving and protecting the right of the public to the use of the these lands and the waters above them for those purposes."

# Fishery Management Objectives

- **S**pecific
- **M**easurable
- **A**chievable
- **R**elated to goal
- **T**ime-constrained

# Fishery Management Objectives

- “Better Fishing”
  - Not S, Marginally M, A, R, Not T
- Increase catch rates of Chinook salmon
  - Marginally S, M, A, R, not T
- Increase average catch rates of Chinook salmon to 0.5 fish/hour or more by 2007
  - S, M, maybe A, R, T

# Fishery Management Objectives

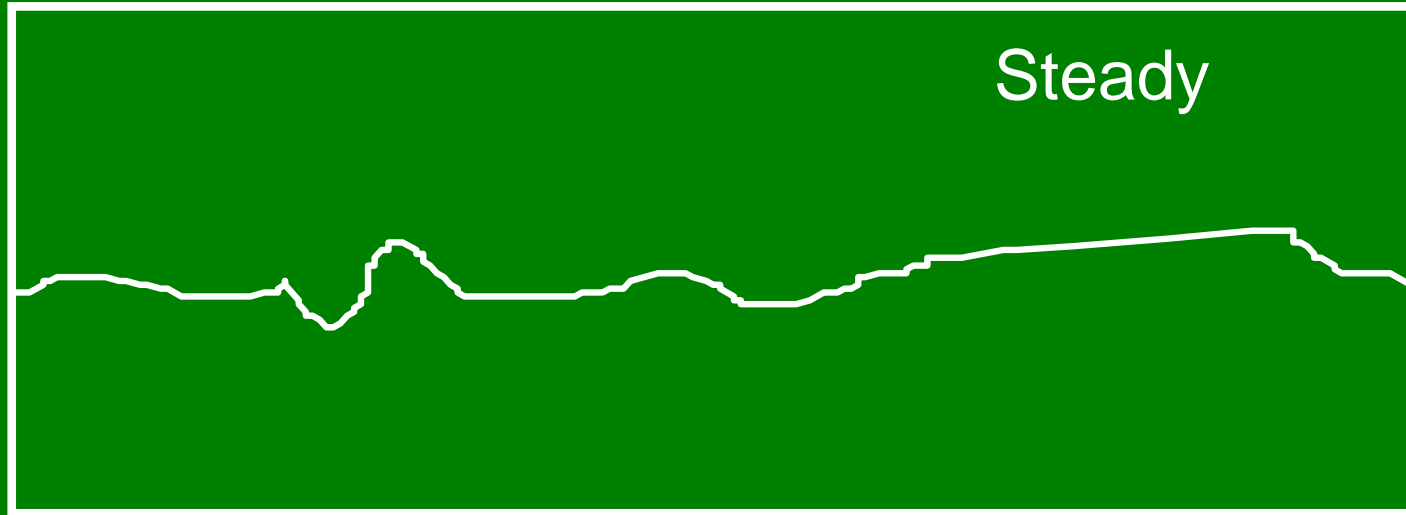
- Increase average catch rates of Chinook salmon to 0.5 fish/hour or more by 2007 by implementing bag limits
  - By adding the phrase “by implementing bag limits”, we are mixing an objective with a method to achieve the objective
  - We don’t want to do this because it constrains the way we think about achieving the objective

# Fishery Management Tools

- Populations
  - Stocking
  - Fish Community Manipulation
- People
  - Fishing Regulations
  - Allocation issues
- Habitat
  - Wetland preservation
  - River restoration
  - Water quality management

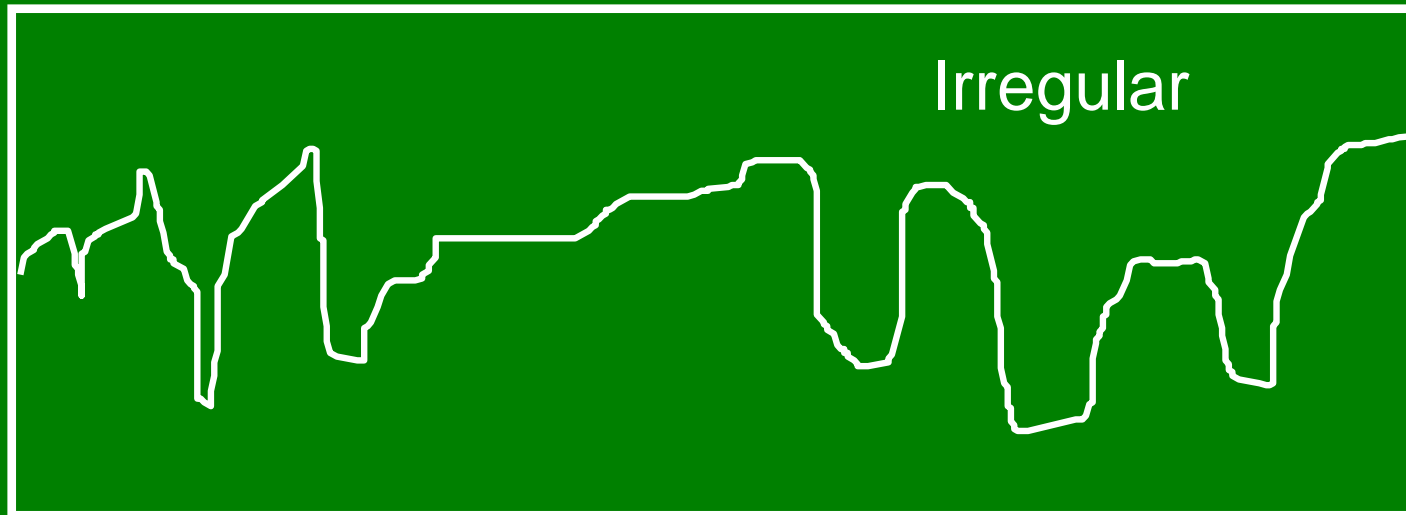
# Population Dynamics

Numbers



Time

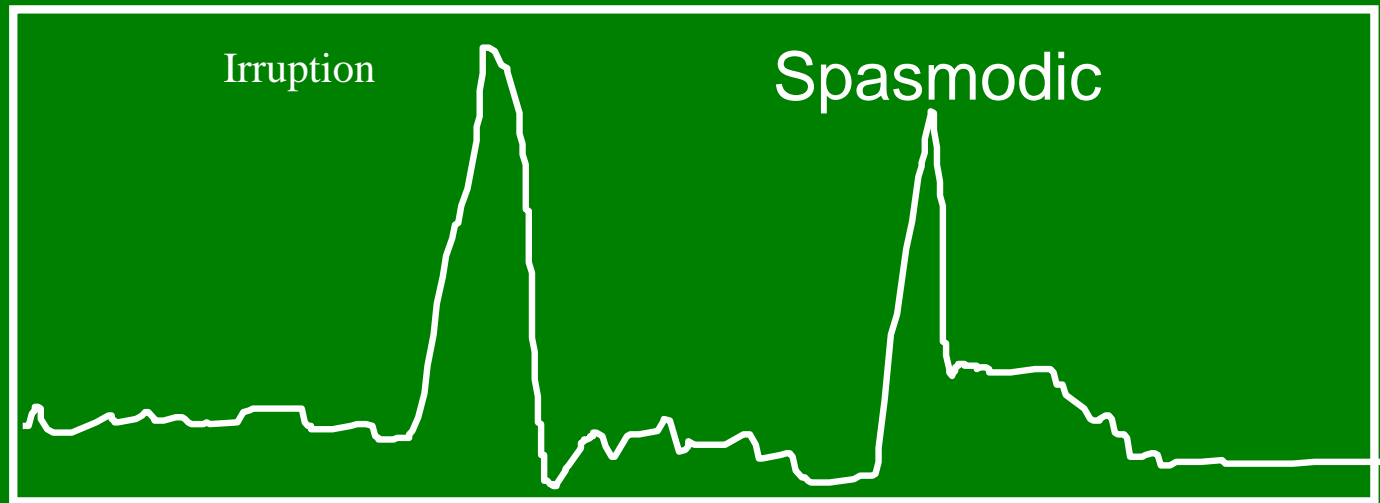
Numbers



Time

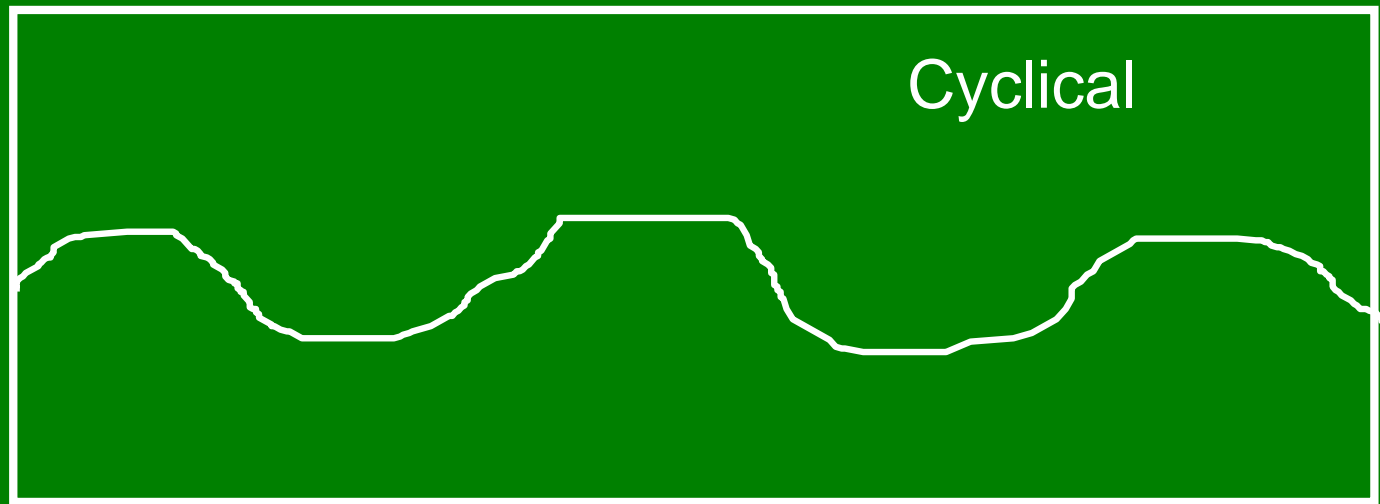


Numbers



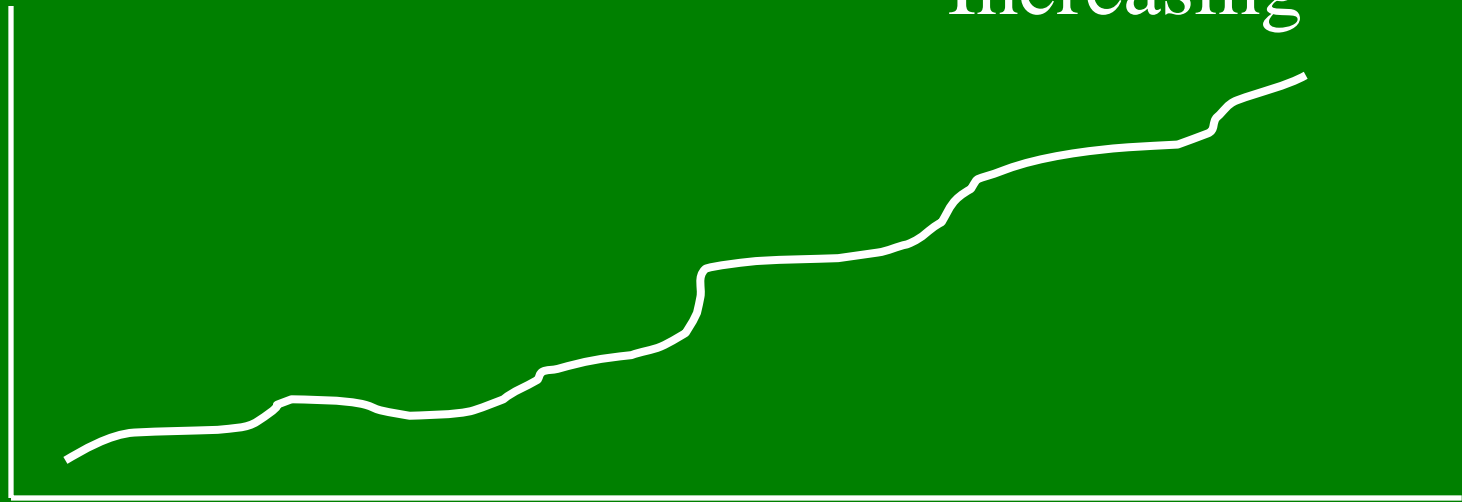
Time

Numbers



Time

Numbers



Increasing

Time

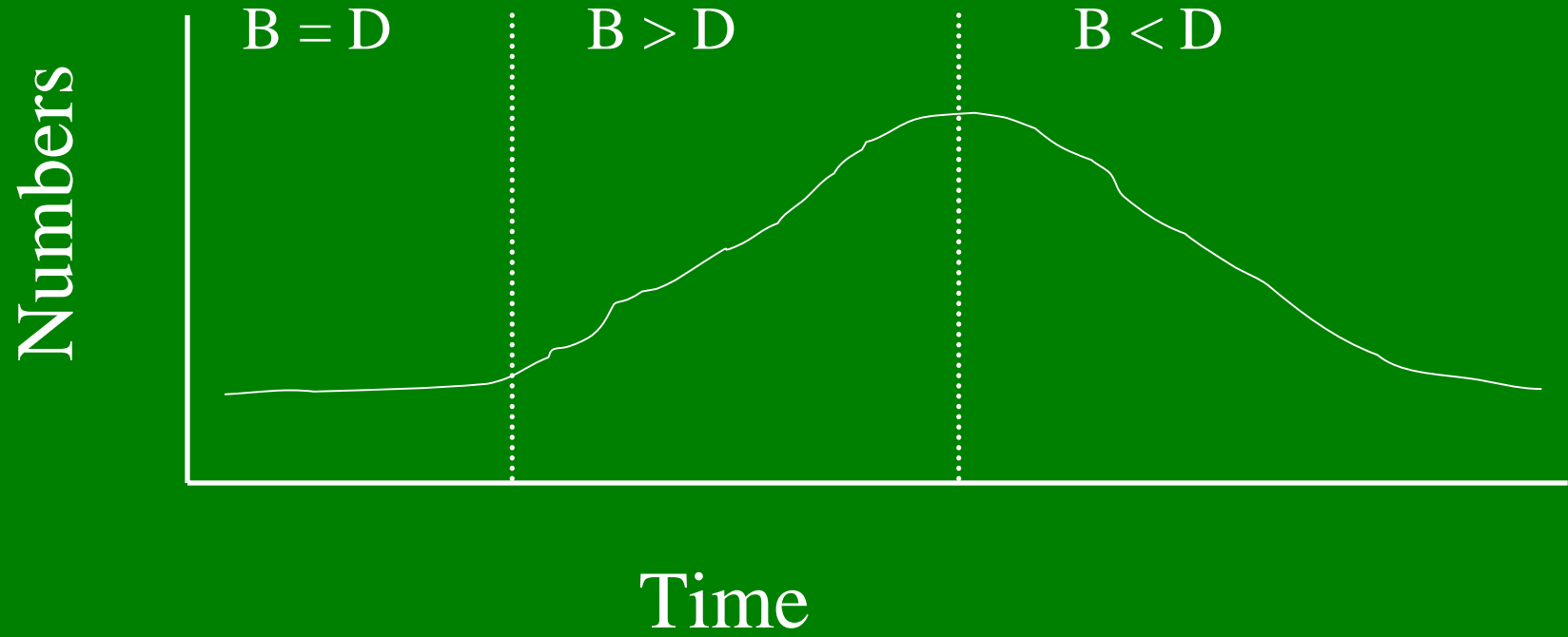
# Thought Question

You stock a pond with 10 fish.

What factors would influence the population dynamics of this new population?

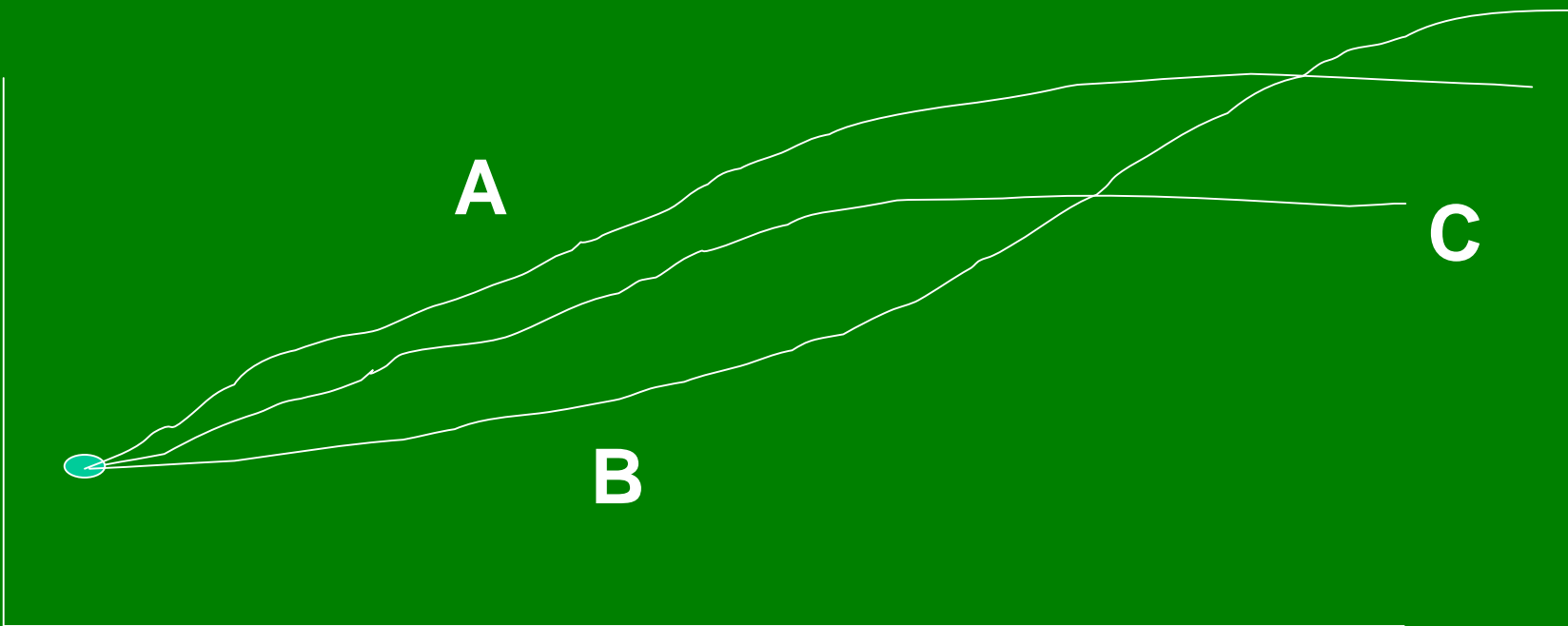
# Factors affecting population

- Birth rate
- Death rate
- Immigration/Emigration



# Factors affecting population

- Birth rate
  - Sex Ratio
  - Fecundity (number of eggs)
  - Age structure
  - Spawning habitat
- Death rate
  - Predators (including people!)
  - Environment
  - Food Resources
  - Age structure



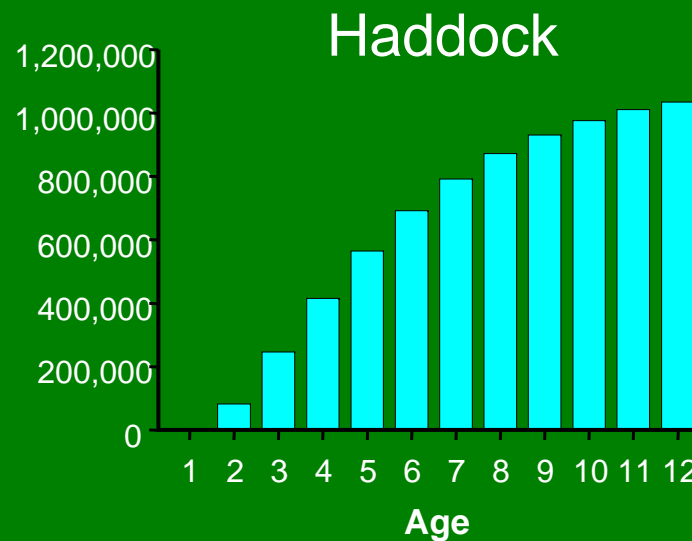
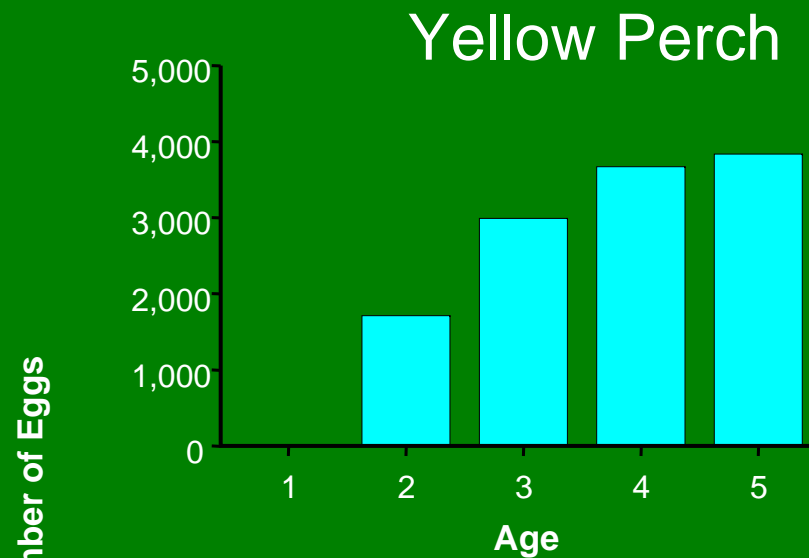
# Key Points

- What is the rate of increase when population is reduced
- What is the eventual number that is achieved
- How does the rate of increase and number achieved vary in response to the fishery, habitat changes, or changes in other aquatic populations?



# Birth Rates

# Birth Rates: Fecundity



# Reproductive Guilds

## A. Nonguarders

- open substrate spawners
- brood hiders
- lots of small eggs

## B. Guardians

- substrate choosers
- nest spawners
- larger eggs

## C. Bearers

- external bearers
- internal bearers
- larger offspring

# Hermaphroditism

- Protandry
  - Start life as a male, then become female
  - Sea basses and groupers
- Protogyny
  - Start life as a female, then become male
  - Wrasses, parrot fish
- Self-fertilizing
  - Simultaneously male and female
  - Sea basses and grouper

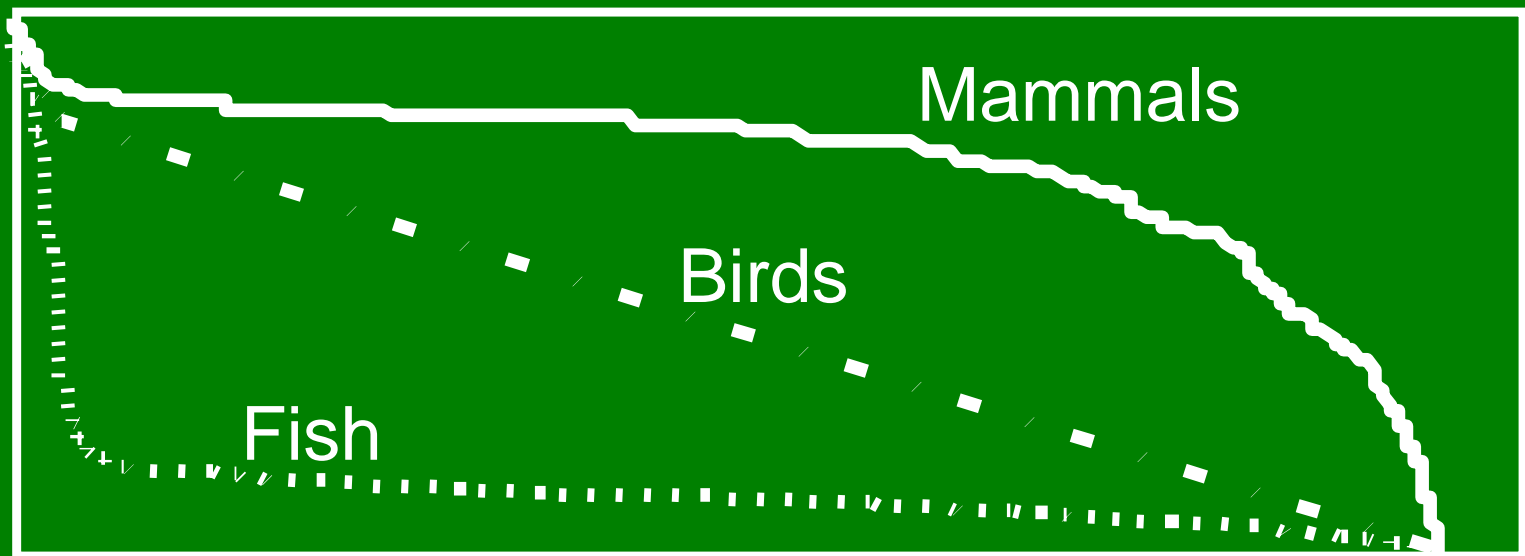
## • Parthenogenesis

- Female only
- Some mollies – in this case, male is needed to initiate egg development but no gene transfer
- Very common in Cladocerans (Daphnia, or “water fleas”)

# Survival Rate

# Survival Curves

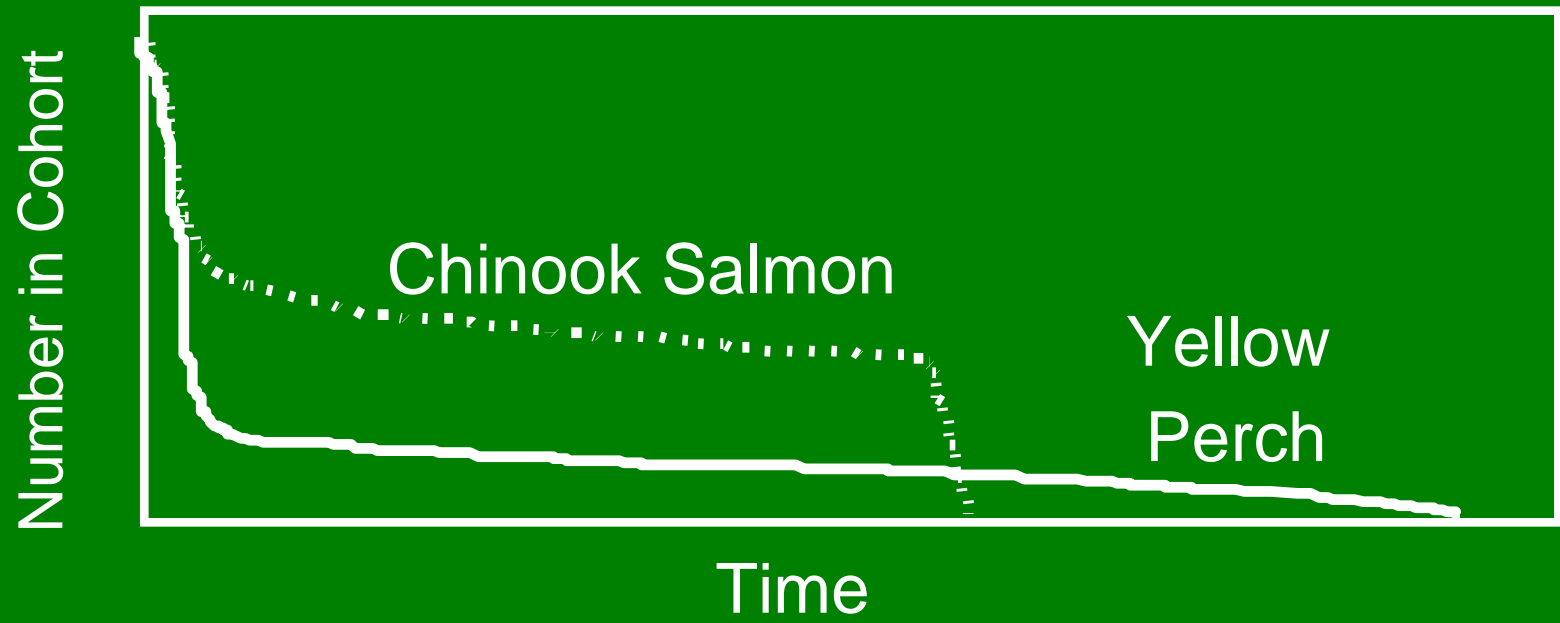
Numbers in Cohort



Time

# Lifetime Changes in Size

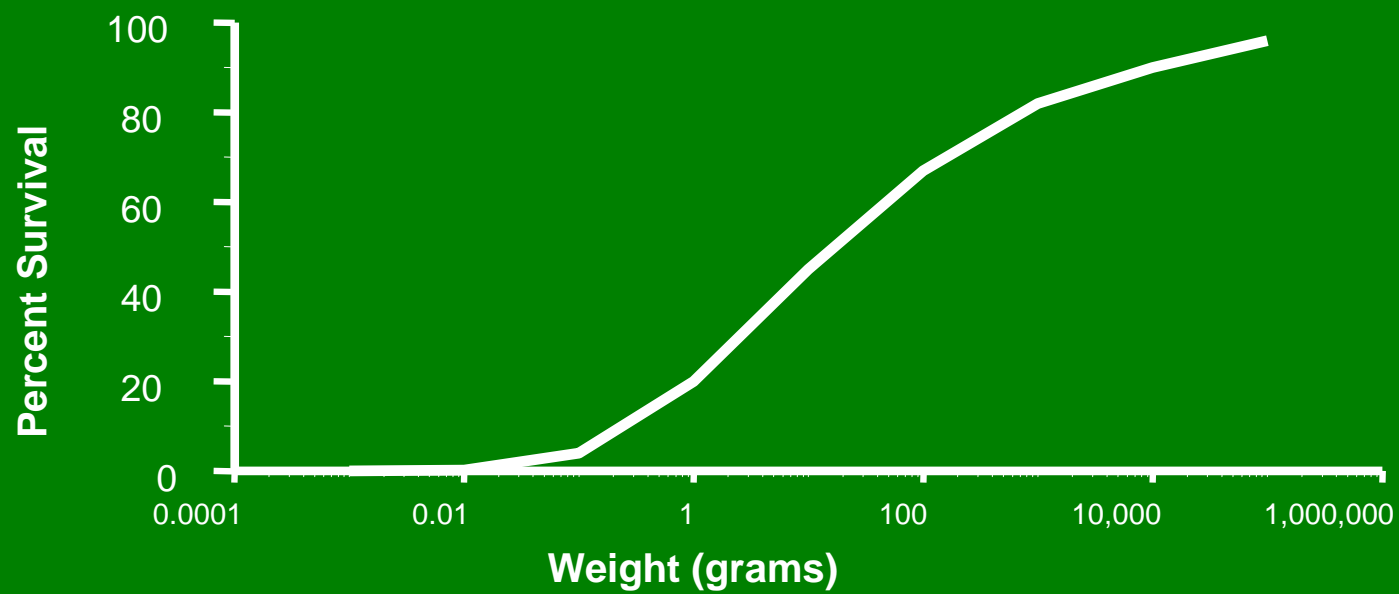
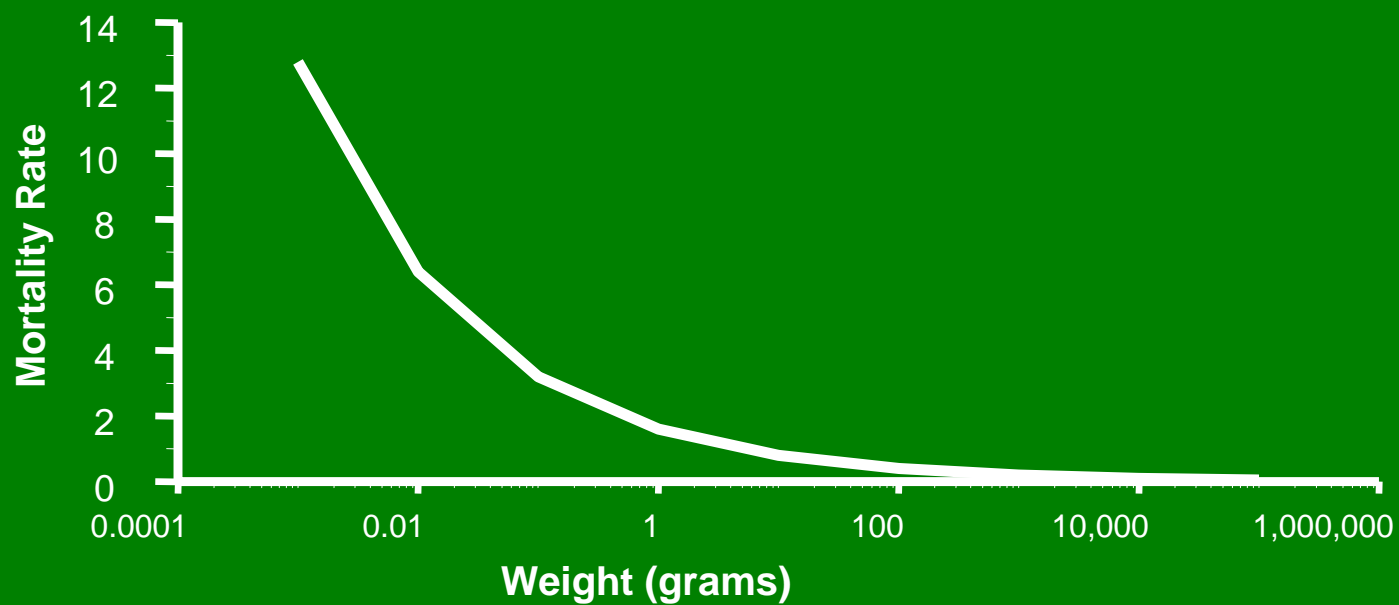
|                        | Birth<br>Weight | Adult<br>Weight | Ratio   |
|------------------------|-----------------|-----------------|---------|
| Mammals<br>(Humans)    | 3,000 g         | 68,000 g        | 23      |
| Birds<br>(Mallard)     | 50 g            | 1,100 g         | 22      |
| Fish<br>(Yellow Perch) | 0.001 g         | 300 g           | 300,000 |

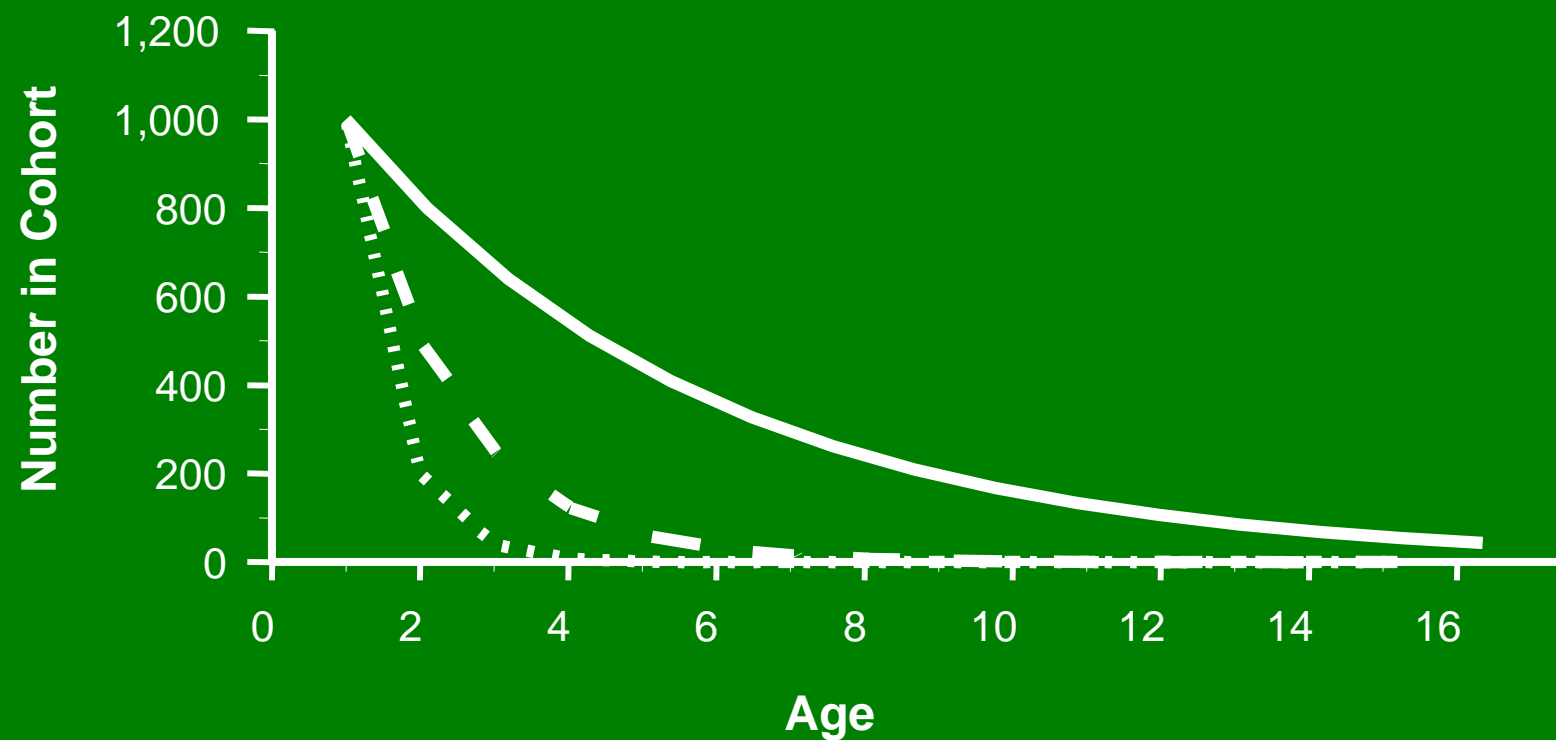


Chinook Salmon - Semelparous

Yellow Perch - Iterparous







20% mortality

50% mortality

80% mortality

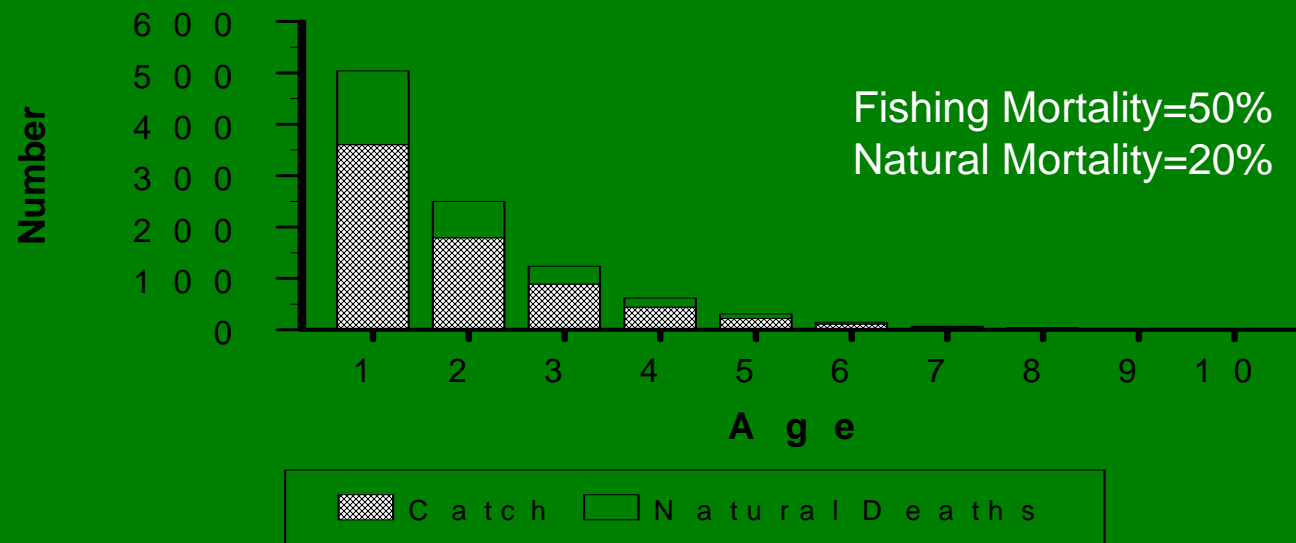
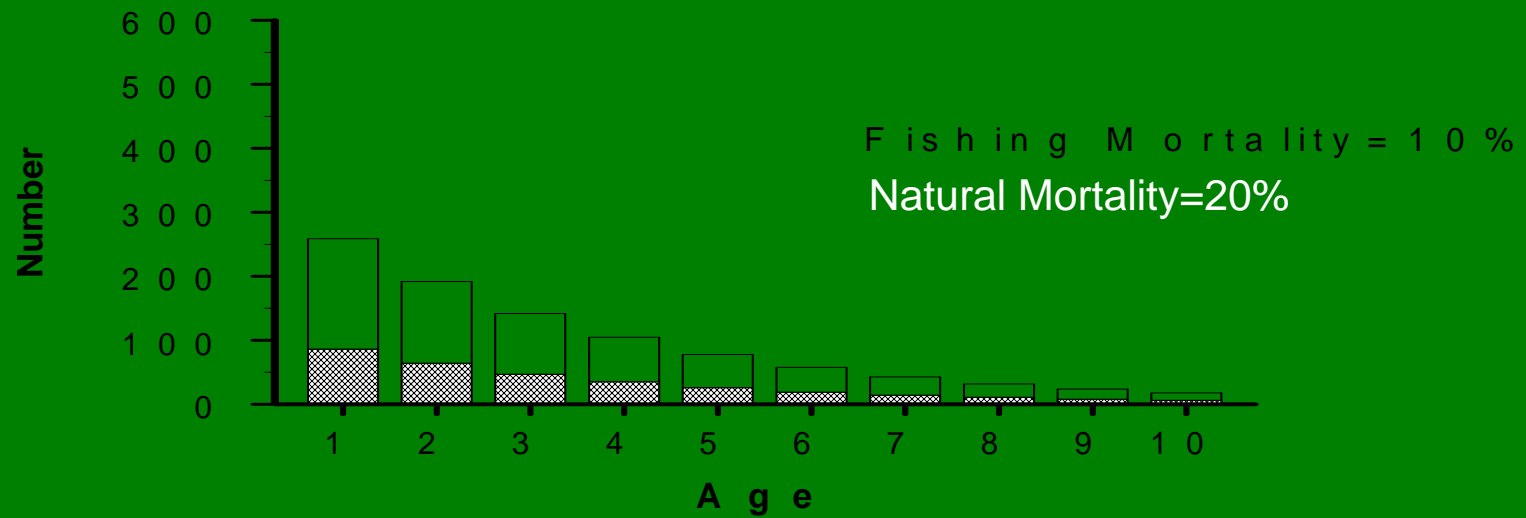
Longevity: Age 20

Age 8

Age 4

Natural Mortality=20%  
Fishing Mortality=10%

|     |            |       | Natural   |              | Weight (g) | Yield (kg)   |
|-----|------------|-------|-----------|--------------|------------|--------------|
| Age | Population | Catch | Mortality | Total Deaths |            |              |
| 1   | 1000       | 86    | 173       | 259          | 67         | 5.8          |
| 2   | 741        | 64    | 128       | 192          | 483        | 30.9         |
| 3   | 549        | 47    | 95        | 142          | 1177       | 55.8         |
| 4   | 407        | 35    | 70        | 105          | 1968       | 69.1         |
| 5   | 301        | 26    | 52        | 78           | 2714       | 70.6         |
| 6   | 223        | 19    | 39        | 58           | 3354       | 64.7         |
| 7   | 165        | 14    | 29        | 43           | 3861       | 55.1         |
| 8   | 122        | 11    | 21        | 32           | 4269       | 45.2         |
| 9   | 91         | 8     | 16        | 24           | 4569       | 35.8         |
| 10  | 67         | 6     | 12        | 17           | 4803       | 27.9         |
|     |            |       |           |              |            | <b>460.9</b> |



Natural Mortality=20%  
Fishing Mortality=50%

| Age | Population | Catch | Natural Mortality | Total Deaths | Weight (g) | Yield (kg) |
|-----|------------|-------|-------------------|--------------|------------|------------|
| 1   | 1000       | 360   | 144               | 503          | 67         | 24.1       |
| 2   | 497        | 179   | 71                | 250          | 483        | 86.2       |
| 3   | 247        | 89    | 35                | 124          | 1177       | 104.4      |
| 4   | 122        | 44    | 18                | 62           | 1968       | 86.7       |
| 5   | 61         | 22    | 9                 | 31           | 2714       | 59.3       |
| 6   | 30         | 11    | 4                 | 15           | 3354       | 36.4       |
| 7   | 15         | 5     | 2                 | 8            | 3861       | 20.8       |
| 8   | 7          | 3     | 1                 | 4            | 4269       | 11.4       |
| 9   | 4          | 1     | 1                 | 2            | 4569       | 6.1        |
| 10  | 2          | 1     | 0                 | 1            | 4803       | 3.2        |

438.6

Natural Mortality=20%  
Fishing Mortality=20%

| Age | Population | Catch | Natural Mortality | Total Deaths | Weight (g) | Yield (kg) |
|-----|------------|-------|-------------------|--------------|------------|------------|
| 1   | 1000       | 165   | 165               | 330          | 67         | 11.0       |
| 2   | 670        | 110   | 110               | 221          | 483        | 53.3       |
| 3   | 449        | 74    | 74                | 148          | 1177       | 87.2       |
| 4   | 301        | 50    | 50                | 99           | 1968       | 97.7       |
| 5   | 202        | 33    | 33                | 67           | 2714       | 90.3       |
| 6   | 135        | 22    | 22                | 45           | 3354       | 74.8       |
| 7   | 91         | 15    | 15                | 30           | 3861       | 57.7       |
| 8   | 61         | 10    | 10                | 20           | 4269       | 42.8       |
| 9   | 41         | 7     | 7                 | 13           | 4569       | 30.7       |
| 10  | 27         | 5     | 5                 | 9            | 4803       | 21.6       |

567.3

Natural Mortality=20%

Fishing Mortality=50% beginning at age 3

| Age | Population | Catch | Natural Mortality | Total Deaths | Weight (g) | Yield (kg) |
|-----|------------|-------|-------------------|--------------|------------|------------|
| 1   | 1000       | 0     | 181               | 181          | 67         | 0.0        |
| 2   | 819        | 0     | 148               | 148          | 483        | 0.0        |
| 3   | 670        | 241   | 96                | 337          | 1177       | 283.8      |
| 4   | 333        | 120   | 48                | 168          | 1968       | 235.6      |
| 5   | 165        | 59    | 24                | 83           | 2714       | 161.3      |
| 6   | 82         | 30    | 12                | 41           | 3354       | 99.0       |
| 7   | 41         | 15    | 6                 | 21           | 3861       | 56.6       |
| 8   | 20         | 7     | 3                 | 10           | 4269       | 31.1       |
| 9   | 10         | 4     | 1                 | 5            | 4569       | 16.5       |
| 10  | 5          | 2     | 1                 | 3            | 4803       | 8.6        |

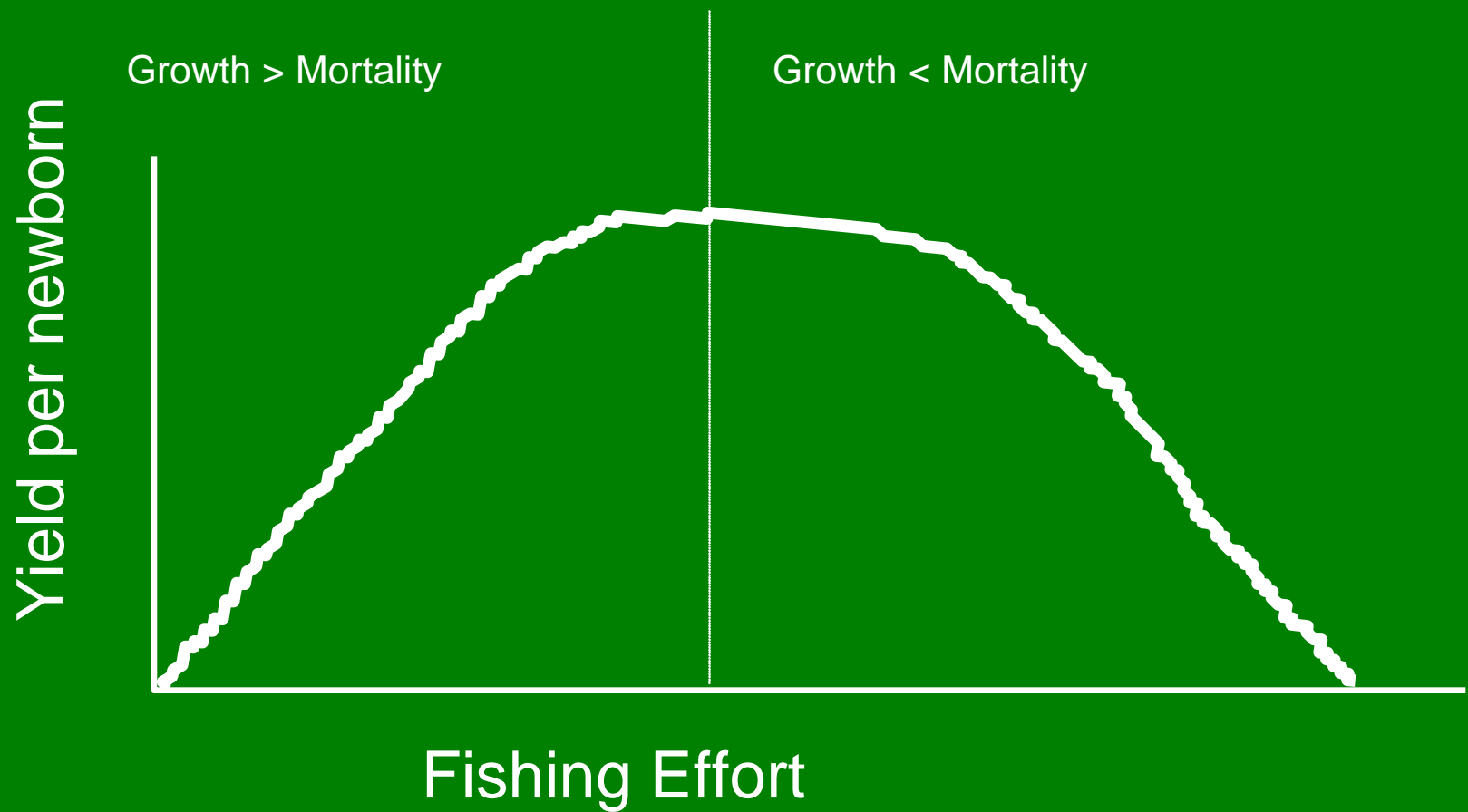
**892.5**

Fishing Mortality=50% beginning at age 7

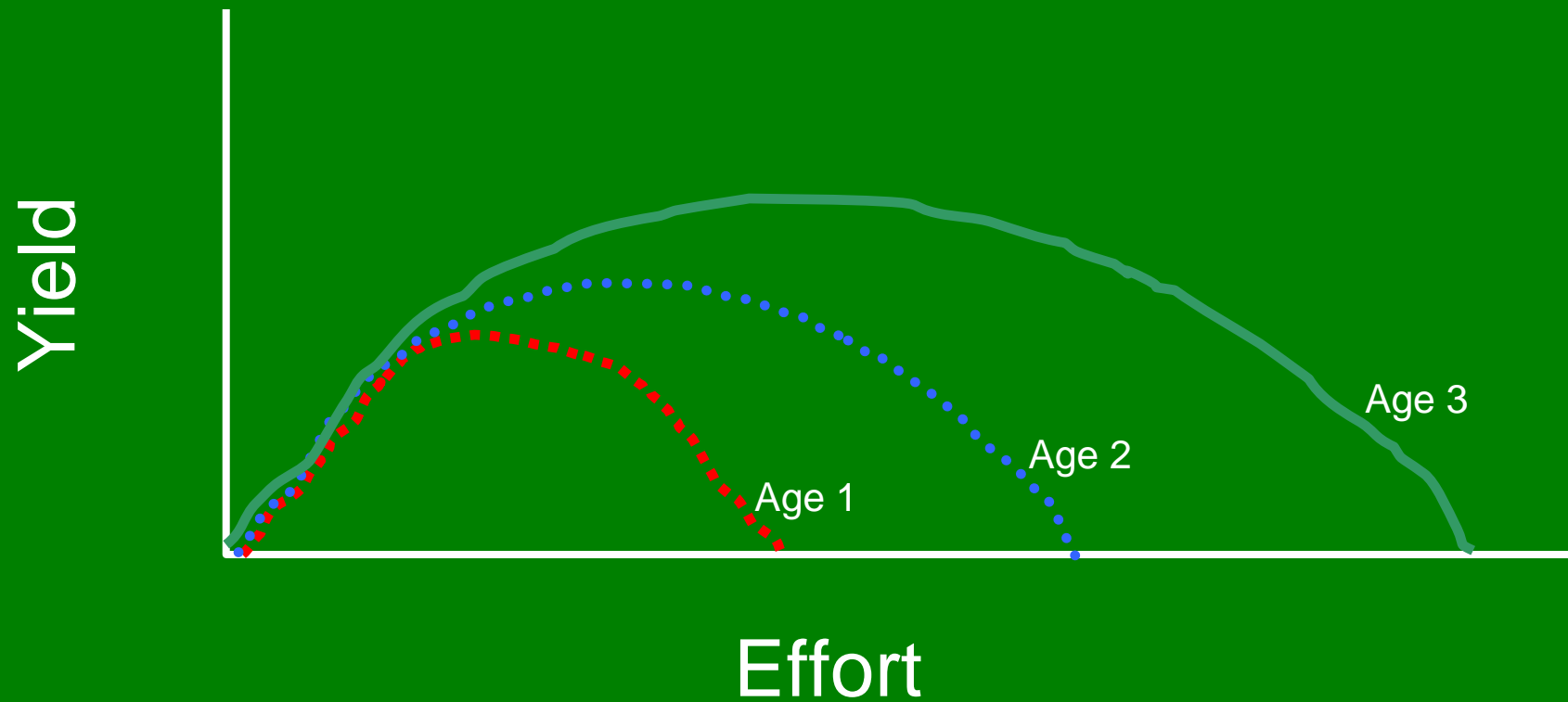
| Age | Population | Catch | Natural Mortality | Total Deaths | Weight (g) | Yield (kg) |
|-----|------------|-------|-------------------|--------------|------------|------------|
| 1   | 1000       | 0     | 181               | 181          | 67         | 0.0        |
| 2   | 819        | 0     | 148               | 148          | 483        | 0.0        |
| 3   | 670        | 0     | 122               | 122          | 1177       | 0.0        |
| 4   | 549        | 0     | 99                | 99           | 1968       | 0.0        |
| 5   | 449        | 0     | 81                | 81           | 2714       | 0.0        |
| 6   | 368        | 0     | 67                | 67           | 3354       | 0.0        |
| 7   | 301        | 108   | 43                | 152          | 3861       | 418.2      |
| 8   | 150        | 54    | 22                | 75           | 4269       | 229.6      |
| 9   | 74         | 27    | 11                | 37           | 4569       | 122.0      |
| 10  | 37         | 13    | 5                 | 19           | 4803       | 63.7       |

**833.5**

# Surplus Production

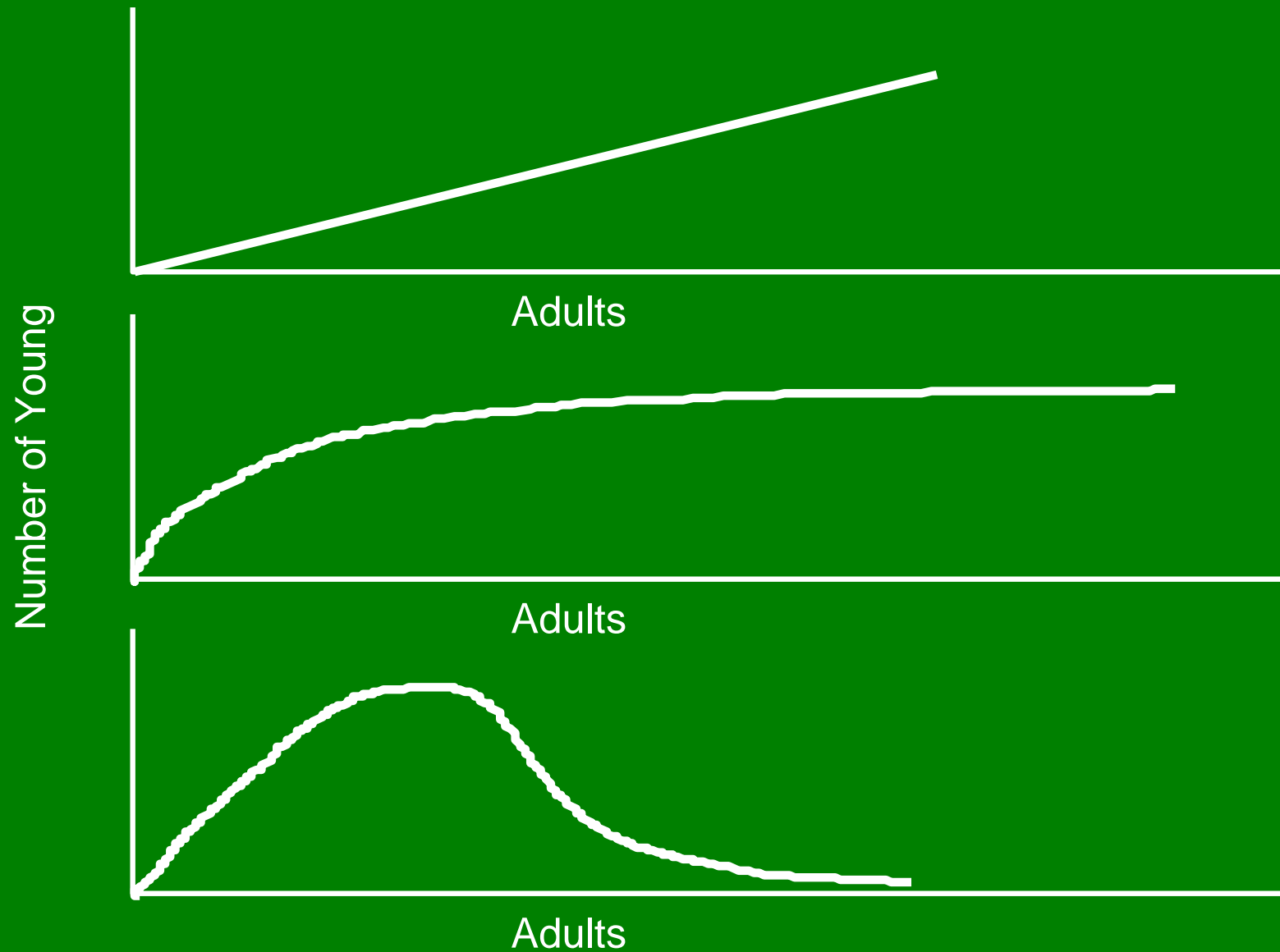


# Surplus Production





# Reproduction Revisited: Stock and Recruitment



# Integrating Population Dynamics with Fishery Management Tools

- Populations
  - Stocking increases births
  - Fish Community Manipulation alters survival rate and age structure
- People
  - Fishing Regulations alters survival rate and age structure
  - Allocation issues \* Primarily a human issue\*
- Habitat
  - Wetland preservation alters birth rate
  - River restoration alters birth rate
  - Water quality management alters birth rate and survival rate